CHAPTER 10

NOISE AND VIBRATION

FINAL ENVIRONMENTAL IMPACT STATEMENT

Brightwater Regional Wastewater Treatment System

VOLUME 2

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Noise and Vibration

10.1 Introduction

10.1.1 Overview of the Chapter

This chapter addresses the affected environment, impacts to the environment, mitigation measures, and significant unavoidable adverse impacts related to noise and vibration for the Brightwater Regional Wastewater Treatment System (Brightwater System). References cited herein can be found at the end of the chapter.

This chapter has been summarized to focus on relevant findings and conclusions of the noise and vibration analysis. Brief discussions of the methods used for analysis are in the Study Methodology section. The Regulatory Environment section under Affected Environment Common to All Systems is included to provide context for the discussion of impacts; however, full descriptions of regulatory background and methodologies are contained in Appendix 10-A, Noise and Vibration: Treatment Plant, and Appendix 10-B, Noise and Vibration: Conveyance.

Comments on the Draft EIS were received from state, federal, and local agencies, public interest groups, and individuals. The majority of the comments fell into seven main categories:

1. Include sound level output of equipment used during operation in addition to sound levels anticipated during construction.
2. List equipment that would result in vibration during plant operation. Discuss vibration levels associated with the equipment and potential engineered mitigation for the potentially damaging vibrations.
3. Develop a Noise Control Plan. Include predicted noise sources and attenuation measures in detail.
4. Provide a quantitative evaluation of expected frequency and duration of vibration impacts from all high-inertia rotating equipment.
5. Provide a quantitative evaluation of mitigation measures of all construction noise impacts. Commit to specific hours and days that such impacts may be experienced.

6. Discuss what mitigation measures would be used to prevent unacceptable increases over existing sound levels.
7. Provide additional noise monitoring stations and data at the northern and western sides of the Route 9 site, closer to residential receptors.

In response to the comments, additional details are provided in Appendices 10-A, Noise and Vibration: Treatment Plant and 10-B, Noise and Vibration: Conveyance.

Some of the information from the Draft EIS was rearranged to make it easier for the reader to find. Additional noise and vibration analysis was also completed for the conveyance system, based upon more specific design information for portals and other conveyance facilities.

10.1.2 Study Methodology

Noise and vibration impacts were estimated using the following methods:

- Selection of noise and vibration monitoring locations based on proximity to residential areas and representative of existing ambient nighttime minimum and daytime maximum levels on residential land use near the treatment plant sites.
- Identification of existing noise and vibration sources that would be modified or eliminated by the project elements when the project is constructed.
- Consideration of project-generated noise and vibration received at noise-sensitive properties.

Assumptions included the following:

- Construction noise and vibration would occur only during times allowed by applicable codes; otherwise, variances would be sought for construction outside those times.
- If such variances are granted, construction noise levels would be required to meet the nighttime noise level limits required by the applicable codes.
- Operating noise level limits would be achieved by mitigation of noise levels as part of the design of treatment plant and conveyance facilities. Noise levels at the nearest land use boundaries would not exceed regulated noise limits specified for the land use of those boundaries.

10.2 Affected Environment

10.2.1 Affected Environment Common to All Systems

10.2.1.1 Regulatory Environment Common to All Systems

Noise

State and local governments have primary responsibility for controlling noise sources and regulating outdoor noise levels in the environment. Washington Administrative Code (WAC) 173-60-040 establishes noise limits that vary according to the land use of the property where the noise source is located and the property receiving the noise. Land use designations and zoning for the treatment plant sites and conveyance corridors are discussed in Chapter 11. These limits are administered by the Washington State Department of Ecology (Ecology). Ecology's maximum permissible sound levels are shown in Table 10-1. Treatment plant construction noise is exempt under WAC 173-60-050, Exemptions, where "sounds created by the installation or repair of essential utility service" are exempt during daytime hours from the maximum noise levels specified. However, some local jurisdictions have more strict construction exemption time requirements.

Table 10-1. Ecology's Maximum Permitted Noise Levels (dBA)

Land Use of Noise Source	Land Use of Receiving Property			
	Residential		Commercial	Industrial
	Day	Night[a]		
Residential	55	45	57	60
Commercial	57	47	60	65
Industrial	60	50	65	70

[a] Maximums are 10 dBA lower than daytime levels for residential receiving property from 10 p.m. to 7 a.m.
Source: WAC 173-60-040

Noise levels at the treatment plant sites would be regulated by the City of Edmonds for the Unocal site and Snohomish County for the Route 9 site; for a more detailed discussion of their regulations, see Appendix 10-A, Noise and Vibration: Treatment Plant. For a more detailed discussion of the regulations of the jurisdictions through which the conveyance corridors would pass, see Appendix 10-B, Noise and Vibration: Conveyance. City of Edmonds Title 17.60.010, Zoning Performance Standards, regulates the noise level at the residential boundary during the nighttime hours of 11:30 p.m. to

6 a.m., to 45 dBA. Snohomish County Code, Chapter 10.01, limits noise levels during nighttime hours (between 10 p.m. and 7 a.m.) to 47 dBA at residential land use in rural zones from industrial land use sources, which would apply to Brightwater treatment facilities operations.

Two cities along the Brightwater System conveyance corridors (Bothell and Woodinville) have adopted the Ecology standards shown in Table 10-1. Other municipalities have adopted various standards for noise levels as shown in Table 10-2. In general, construction noise is exempt from maximum permissible levels during daytime hours, although these hours vary among the jurisdictions. A number of the municipalities, including Brier, Lake Forest Park, Mountlake Terrace, Shoreline, and Woodway have not adopted specific maximums, but do regulate noise on a "nuisance" basis and define construction noise outside of daytime hours as a nuisance subject to enforcement.

Vibration

Only the City of Edmonds regulates vibration at the boundary of the vibration source. The vibration impact criteria of the Federal Transit Administration (FTA) can be used to evaluate the impact of ground-borne vibration and noise generated by ground-borne vibration. For a discussion of the regulations and the FTA standards, see Appendix 10-B, Noise and Vibration: Conveyance.

Table 10-2. Summary of Noise Regulations by Jurisdiction

Jurisdiction	Applicable Regulations	Permitted Maximum Noise Levels	Daytime Construction Noise	Night/Weekend Construction Noise
State				
Washington (Ecology)	WAC 173-60-040	See Table 10-1	Exempt	Construction not permitted 10 p.m. to 7 a.m., where noise reception is within residential zones.
Counties				
King	12.88, King County Code	See Appendix 10-B: Noise and Vibration: Conveyance	May exceed designated levels by up to 25 dBA	For rural or residential districts, must be 10 dBA below permitted daytime levels from 10 p.m. to 7 a.m. weekdays, 10 p.m. to 9 a.m. weekends and holidays
Snohomish	10.01, Snohomish County Code	See Appendix 10-A: Noise and Vibration: Treatment Plant	Exempt[a]	Must be 10 dBA below permitted daytime levels from 10 p.m. to 7 a.m. weekdays, 10 p.m. to 9 a.m. weekends and holidays
Municipalities				
Bothell	8.26, Bothell Municipal Code	Same as WAC 173-60-040 (see Table 10-1)	Exempt	Construction not permitted 6 p.m. to 7 a.m. weekdays; after 5 p.m. Saturdays; Sundays and holidays
Brier	8.08, Brier Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 6 p.m. to 7 a.m. weekdays; after 5 p.m. Saturdays; Sundays and holidays

Table 10-2. Summary of Noise Regulations by Jurisdiction (cont.)

Jurisdiction	Applicable Regulations	Permitted Maximum Noise Levels	Daytime Construction Noise	Night/Weekend Construction Noise
		Municipalities (cont.)		
Edmonds	5.30 and 17.60 Edmonds Municipal Code	See Appendix 10-A	Exempt	Construction not permitted 10 p.m. to 7 a.m.
Kenmore	12.88, King County Code	Same as King County (see Appendix 10-B)	May exceed designated levels by up to 25 dBA	For rural or residential districts, must be 10 dBA below permitted daytime levels from 10 p.m. to 7 a.m. weekdays, 10 p.m. to 9 a.m. weekends and holidays
Lake Forest Park	8.24, Lake Forest Park Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 9 p.m. to 7 a.m. weekdays; 9 p.m. to 8 a.m. weekends and holidays
Mountlake Terrace	8.20, Mountlake Terrace Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 10 p.m. to 7 a.m. (all days of the week)
Shoreline	9.05, Shoreline Municipal Code	Regulated as nuisance	Exempt	Construction not permitted 10 p.m.-7 a.m. weekdays; 10 p.m.-9 a.m. weekends
Woodinville	8.08, Woodinville Municipal Code	Same as WAC 173-60-040 (see Table 10-1)	Exempt	Construction not permitted 6 p.m.-7 a.m. weekdays; after 5 p.m. Saturdays; Sundays and holidays
Woodway	Woodway Noise Ordinance	Regulated as nuisance	Exempt	Construction not permitted 7 p.m.-7 a.m. weekdays (9 p.m.-7 a.m. during summer); after 5 p.m. Saturdays; Sundays and holidays

[a] Except as otherwise stipulated under SEPA or permit conditions.

10.2.1.2 Health and Safety Considerations Common to All Systems

Noise

Environmental noise effects on human populations include speech interference, sleep disturbance, and annoyance. Figure 10-1 shows sound levels for some common noise sources.

- Normal conversation ranges between 55 and 65 decibel A-weighted (dBA) when the speakers are 3 to 6 feet apart.
- Quiet urban nighttime noise dBAs range in the low 40s.
- Noise levels during the day in a noisy urban area are frequently as high as 80 dBA.
- Noise levels above 110 dBA become intolerable and can result in hearing loss.

The World Health Organization (WHO) has drafted community noise guidelines to document health effects of noise and recommend government actions to manage excessive noise exposure (WHO, 1995).

Vibration

Vibration is the oscillatory motion of ground and buildings caused by events or activities such as earthquakes, vehicles traveling on highways and railroads, and the operation of construction equipment and machinery. Vibration is usually measured in terms of velocity. Figure 10-2 gives information on typical levels of ground-borne vibration.

- Human threshold of perception for vibration is approximately 0.0018 inches per second (inch/sec); 0.0056 inch/sec is considered "distinctly perceptible."
- Background vibration is generally 0.0003 inch/sec.
- A bus or truck going over a bump could produce a level of 0.0032 inch/sec at a distance of 50 feet.
- Bulldozers and other heavy tracked construction equipment could produce 0.0316 inch/sec vibration at 50 feet.

10.2.2 Affected Environment: Route 9 System

10.2.2.1 Treatment Plant: Route 9

Noise: Route 9 Treatment Plant

A noise evaluation was conducted using sound level monitoring equipment conforming to American National Standards Institute (ANSI) S1.4, Type 1 and Type 2, to gather and analyze noise levels. Microphones were calibrated at the start of each monitoring period and checked at the conclusion of monitoring. Noise levels were recorded at two locations at the Route 9 site. These are shown as NML-1 and NML-2 on Figure 10-3. The two locations were monitored for 24-hour periods on weekdays from April 25 to April 26, 2002, and April 29 to April 30, 2002. The existing L50 noise levels, which is the sound level that is exceeded 50 percent of the time (the 50th percentile) for the period under consideration, can be summarized as follows:

- The minimum hourly L50 noise level for the two monitoring locations, 45 dBA, occurred during the weekday nighttime hours of 2 a.m. to 3 a.m. at noise monitoring location NML-1.
- The maximum L50 noise level, 64 dBA, occurred at NML-1 from 9 p.m. to 10 p.m. on a weekday.

Vibration: Route 9 Treatment Plant

Vibration was measured using an accelerometer, which feeds information about ground or building movement to a spectrum analyzer. The analyzer then produces information that can be used to determine the velocity of the vibration. For this project, vibration was monitored with a sound level meter conforming to ANSI S1.4, Type 1, using a calibrated vibration transducer (accelerometer) conforming to International Organization for Standardization (ISO) 10012-1.

Table 10-3 defines ground-borne vibration impact levels based on land use and generally resulting in acceptable community response. Table 10-4 indicates associated human perception of vibration levels. Although the data are related to periodic vibration from transportation sources, the human perception levels in Table 10-4 are relevant to both construction and operation vibration, and the "frequent event" levels of Table 10-3 can be compared to existing vibration levels for rating the existing conditions.

Table 10-3. Ground-Borne Vibration Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Level (inch/sec RMS)	
	Frequent Events[a]	Infrequent Events[b]
Category 1: Buildings where vibration would interfere with interior operations, such as certain microelectronics manufacturing processes	0.0018	0.0018
Category 2: Residences and buildings where people normally sleep	0.0040	0.0100
Category 3: Institutional land uses with primarily daytime use such as schools and churches	0.0056	0.0141

[a] Frequent Events are defined as more than 70 vibration events per day.
[b] Infrequent Events are defined as fewer than 70 vibration events per day.
Source: USDOT (1998).

Table 10-4. Human Response to Different Levels of Ground-Borne Vibration

RMS Vibration Velocity Level (inch/sec)	Human Response
0.0018	Approximate threshold of perception for many humans.
0.0056	Approximate dividing line between barely perceptible and distinctly perceptible. Many people find train vibration at this level unacceptable.
0.0178	Vibration acceptable only if there are an infrequent number of events per day.

RMS = Root-mean-squared
Source: USDOT (1998)

Category 2 land use as defined in Table 10-3 would be used as the criterion applicable to residential receivers adjacent to both the Unocal and Route 9 sites. The vibration values indicate the maximum for a single event.

Vibration levels were recorded at one location at the Route 9 site, shown as VML-1 on Figure 10-3. The location was monitored for 24-hour periods on weekdays from April 25 to April 26, 2002, and April 29 to April 30, 2002. The existing vibration conditions at the Route 9 site can be summarized as follows:

- A minimum ambient ground vibration level of 0.0000085 inch/sec RMS velocity was measured July 10, 2002, at monitoring station VML-1.
- A maximum ground vibration level of 0.000025 inch/sec RMS velocity at this location was measured while a heavy truck was passing on SR-522.

10.2.2.2 Conveyance: Route 9

Ambient noise and vibration along the conveyance corridors would be measured prior to construction for inclusion as guidance to permit conditions or contract requirements. Existing noise levels along the corridors vary widely, depending upon land uses and activities. Predominant noise sources include major roadways I-5, I-405, SR-522, SR-527, and SR-104, and specific land uses in the vicinity of the corridors. Noise monitoring was not practicable at portal siting areas because of the large amount of land they encompass; however, major regional sources of noise are identified for each corridor.

The primary source of noise along the Route 9 conveyance corridors is traffic from major roadways either adjacent to or within the conveyance corridors. The SR-522 right-of-way is a major source of traffic noise within portal siting areas along the influent portion of the corridors. In addition to roadways creating a source of noise along the corridor, airplanes using Kenmore Air Harbor also create noise along the Route 9 corridors. Kenmore Air Harbor, located along the northern shoreline of Lake Washington, is adjacent to Portal Siting Area 11 in the City of Kenmore. Existing sound levels were measured in the vicinity of Portal Siting Area 11 as part of the Lakepointe Mixed Use Master Plan Draft EIS (King County, 1997). The minimum noise level at 68th Avenue NE near the Lakepointe site was 49.3 dBA, and the maximum hour continuous equivalent level (L_{eq}), which is similar to an average sound level, was 81.8 dBA. The noise levels near residences on the hill north of the site ranged from 56.2 to 78.9 dBA. These residences are likely already exposed to noise levels higher than permitted in the relevant code, King County Code 12.88 (these maximum noise levels are shown in Appendix 10-A, Noise and Vibration: Treatment Plant). Permissible maximum daytime noise levels for residential receiving properties are 60 dBA from industrial land use sources and 57 dBA from commercial land use sources. Nighttime permissible levels are 10 dBA lower than maximum permissible daytime levels.

Existing conditions at the candidate sites for the primary portals are included in Table 10-5. Similar information for the secondary portals is included in Appendix 10-B, Noise and Vibration: Conveyance. See Chapter 16 for a full discussion of roadways and traffic volumes along the Route 9 corridors.

Route 9 Corridors

Along the 195th Street corridor, SR-104, I-5, and I-405 are major sources of traffic noise. See Chapter 16 for a full discussion of roadways and traffic volumes along the Route 9 corridors.

The major source of existing noise along the 228th Street corridor is traffic from SR-527 and SR-104, as well as roadway noise from 228th Street itself. In addition, a private shooting range along 228th Street is a source of noise, particularly on weekends. I-5 and I-405 are also dominant local sources of background noise.

Existing conditions at the candidate sites for the Route 9 primary portals are included in Table 10-5. Similar information for the secondary portals, which are listed in Chapter 3, is included in Appendix 10-B, Noise and Vibration: Conveyance. See Chapter 16 for a full discussion of roadways and traffic volumes along the Route 9 corridors.

Table 10-5. Existing Conditions at Primary Candidate Portal Sites on the Route 9 Corridors

Candidate Site	Adjacent Land Use	Topography	Site Specific Comment	Existing Noise/Vibration Sources
195th Street Corridor				
		Portal 11		
A	Light industrial and commercial uses, retail/business north of NE Bothell Way	Located in a low area on a gentle slope uphill to the north	Area with commercial and light industrial buildings and no trees, trucks in the area	Commercial (heavy, e.g., truck) traffic and local traffic along Bothell Way and Juanita Dr. NE; seaplanes
B	Light industrial and commercial uses, retail/business north of NE Bothell Way	Located in a low area on a gentle slope uphill to the north	Area with commercial and light industrial buildings and no trees, trucks in the area	Commercial (heavy, e.g., truck) traffic and local traffic along Bothell Way and Juanita Dr. NE; seaplanes
C	Urban commercial area surrounds site with residential area to northwest	Gentle slope uphill to the northwest	Parking lot with buildings on the north and east side and a few trees along the southwest and southeast	Local traffic from 68th Ave. NE & NE 181st St., seaplanes

Table 10-5. Existing Conditions at Primary Candidate Portal Sites on the Route 9 Corridors (cont.)

Candidate Site	Adjacent Land Use	Topography	Site Specific Comment	Existing Noise/Vibration Sources
		Portal 41		
A	Commercial - office park	Flat	Few trees and grass on perimeter, center of site is asphalt with concrete footings, ready to be built on	Commercial traffic from North Creek Parkway and NE 195th St.
C	Commercial—office park to the north, south, and west, residential to the east, ball field to the southwest	Moderate uphill to the east, steep uphill just offsite to the east	Grassy park area with a few trees and pedestrian path	Commercial traffic from 120th Ave. NE and NE Hollyhills Drive
D	Commercial—office park, sportsfield to the west, grassy park area to the northeast	Flat	Ball field with lights	Commercial and local traffic along 120th Ave. NE
J	Commercial—office park, vacant site to the north	Flat, manmade stormwater drainage channel on the south-east side of the site	Few scattered shrubs and trees (mostly deciduous) along the perimeter and concentrated on the east and south-east corner of the site	Commercial traffic from North Creek Parkway and NE 195th Street
X	Light Industrial, office park, freeway to the west	Flat	North Creek Pump Station	Traffic along I-405 and other nearby roads
W	Residential with some open space	Slopes uphill to the west	Houses, dense evergreen (approx. height 40-80 ft) along west side of the site forming potential screen; mixture of deciduous and evergreen (approx. height 20-60 ft) along south and southwest side of the site	Traffic along I-405 and Beardslee Blvd.
		Portal 44		
C	Rural residential and forested, buildings adjacent northwest and southwest	On steep slope uphill to the east, above 80th Ave NE	Many trees	Minimal residential traffic
D	Rural residential, forested, no apparent buildings immediately adjacent to property	Flat and on hill side above 80th Ave NE, western 1/3 of site slopes steeply uphill to the east	Open field with horse barn and houses	Residential traffic from 80th Ave. NE & NE 195th St.

Table 10-5. Existing Conditions at Primary Candidate Portal Sites on the Route 9 Corridors (cont.)

Candidate Site	Adjacent Land Use	Topography	Site Specific Comment	Existing Noise/Vibration Sources
		Portal 44 (cont.)		
E	Rural residential to the south and west with open space to the north and forested to the east	Gentle slope uphill to the west, on higher ground than NE 195th St and adjacent residences	Open field with a few trees to the southeast	Residential traffic from NE 195th St.
		Portal 5		
B	Commercial to the northwest, southeast, and northeast along Ballinger Way NE	Gentle uphill to the northeast	Mostly asphalt with parking, and storage and retail buildings; a few conifer trees along perimeter of southern half of the site	Heavy traffic on Ballinger Rd. NE; nearby I-5 traffic
G	Commercial to the northwest, southeast, and northeast along Ballinger Way NE	Gentle uphill to the northeast	Mostly asphalt with parking, and storage and retail buildings	Heavy traffic on Ballinger Rd. NE; nearby I-5 traffic
X	Commercial to the north, and southeast along Ballinger Way NE, residential to the south	Gentle uphill to the north	Gas station and commercial buildings on site, mostly asphalt with parking	Heavy commercial and local traffic on Ballinger Way NE and 15th Ave. NE; nearby I-5 traffic
		Portal 19		
C	Industrial to the northwest, residential to the east, south and southeast, Puget Sound to the west, wooded area to the northeast	Flat with steep uphill slope just offsite to the east	Grass and few trees on eastern half, large semi-trucks use this road regularly	Nearby railroad, truck traffic along Richmond Beach Dr. NW
228th Street Corridor				
		Portal 11		
		Same as 195th Street Corridor		
		Portal 44		
		Same as 195th Street Corridor		
		Portal 41		
		Same as 195th Street Corridor		
		Portal 39		
B	Rural residential west, south, and east. Office buildings across 228th St. SE to the north	Gentle slope with hill rising to the east	The site has several homes, trees and is located in a depression	Residential/ commercial and local traffic along 228th St. SE, Fitzgerald Rd. and 29th Dr. SE
C	Rural residential and open space surrounding the site.	On hill side	The site has a home and trees. There are buildings adjacent to the site on the west side	Commercial and local traffic along 228th St. SE and 31st Ave. SE

Table 10-5. Existing Conditions at Primary Candidate Portal Sites on the Route 9 Corridors (cont.)

Candidate Site	Adjacent Land Use	Topography	Site Specific Comment	Existing Noise/Vibration Sources
Portal 39 (cont.)				
D	Rural residential with an adjacent building north	Gentle slope	Open field with several homes and a few trees	Commercial and local traffic along 228th St. SE and 31st St. SE
Portal 33				
A	Rural residential area with some trees to the north and east	Moderate uphill	Cleared land with houses, horses, private roads, some trees, and some grass, rural residential	Local residential traffic
C	Rural residential with some trees	Moderate uphill	Southern part of site is commercial and northern part is residential	Local traffic along 228th St. SW
D	Rural residential with some trees	In valley	The site has some trees and one home	Local traffic along Locust Way
Portal 26				
A	Residential with open space to the south	Hill to the east, relatively flat north, south, and west	Ball field with park and buildings with a few trees	Local traffic along Lakeview Dr.
C	Commercial to the north, south, and west along SR-99, residential to the east	Gentle slope, surrounding area is free of large hills	Site is mostly asphalt parking lot/driveway with large strip mall and small strip mall on perimeter	Commercial traffic on SR-99
D	Residential to the north, west, and south, ball field is to the southeast and trees to the east	Hill to the east, relatively flat north, south, and west	Homes, some trees, including many 100'+ conifer trees, trees are in a corridor, interrupted by power lines	Local traffic along 228th St. SW and 74th Ave. W
Portal 19				
Same as 195th Street Corridor				

Portal 41 Influent Pump Station Option

The affected environment for the Route 9–195th Street corridor influent pump station (IPS) Option is the same as that described for Portal 41 in Table 10-5. The City of Bothell has adopted the Washington State noise level standards (refer to Table 10-1). The primary source of noise at Portal 41 is traffic from I-405 and adjacent major roadways. Except for a motel, residential uses are distant from the area.

10.2.2.3 Outfall: Route 9

Major existing noise sources in the vicinity of the outfall zones were identified; however, noise levels were not monitored. Major existing noise sources near Zone 7S at Point Wells include the Burlington Northern-Santa Fe (BNSF) railroad and truck traffic entering and exiting the Chevron Richmond Beach Asphalt Terminal at Point Wells. Boat traffic on Puget Sound and small airplane traffic overhead are also occasional sources of noise.

10.2.3 Affected Environment: Unocal System

10.2.3.1 Treatment Plant: Unocal

Noise: Unocal Treatment Plant

Noise was measured at the Unocal site using the same technique as at the Route 9 site. Three locations, NML-1, NML-2, and NML-3, were monitored for existing noise levels (Figure 10-4 illustrates the monitoring locations). Two of the locations (NML-1 and NML-3) were near the southeast and southwest corners of the site; the third (NML-2) was midway along the northwest side of the site, adjacent to the railroad tracks. Two locations were monitored for 24-hour periods on the weekdays of May 8 and May 9, 2002; the other location was monitored for 24 hours on the weekend days of May 11 and May 12, 2002, and on the weekdays of June 10, 2002, through June 12, 2002. Existing noise conditions at the Unocal site can be summarized as follows:

- The minimum hourly L50 noise level for all three monitoring locations was 32 dBA, which occurred during weekday nighttime hours of 2 a.m. to 3 a.m. at noise monitoring location NML-2.
- The maximum hourly L50 was 48 dBA at NML-2 from 10 a.m. to 11 a.m. on a weekday.
- Minimum noise levels closer to Pine Street residences (36 dBA), NML-1, were approximately 4 dBA higher than the minimum levels near Admiral Way, NML-2, due to wind in the trees near NML-1.

Vibration: Unocal Treatment Plant

Vibration levels were measured with a sound level meter and accelerometer at two of the same locations monitored for noise, using the criteria described in the Affected Environment: Route 9 System section. Vibration monitoring locations are shown as

VML-1 and VML-2 in Figure 10-4. Existing vibration conditions at the Unocal site can be summarized as follows:

- A minimum ambient ground vibration level measurement of 0.000009 inch/sec RMS velocity was measured July 10, 2002, at the Fish Hatchery monitoring location, VML-2.
- A maximum of 0.008 inch/sec RMS velocity was measured on Admiral Way, VML-1, while a freight train was passing. Because this is above 0.0056 inch/sec (see Table 10-4), some residents near the Unocal site may sense vibration events from trains on Admiral Way.

10.2.3.2 Conveyance: Unocal

Major sources of noise along the Unocal conveyance corridor and at portal siting areas include freeways (I-405 and I-5) and major roadways (SR-522 and SR-104). Each of these transportation corridors experiences high volumes of traffic that dominate the noise environment in the vicinity. The two freeways are located outside of portal siting areas, although Portal Siting Area 5 is immediately adjacent to I-5. In addition, the SR-522 and SR-104 rights-of-way are inside primary Portal Siting Areas 14, 11, 7, and 3 and secondary Portal Siting Areas 5, 12, 13, and 10. See Chapter 16 for a complete discussion of roadways and traffic volumes within the vicinity of the Unocal corridor.

In addition to roadways creating a source of noise, airplanes using Kenmore Air Harbor also create noise along the Unocal corridor. See the discussion in the section titled Affected Environment: Route 9 System.

Existing conditions at the candidate sites for the primary portals are included in Table 10-6. Similar information for the secondary portals, which are listed in Chapter 3, is included in Appendix 10-B, Noise and Vibration: Conveyance.

Table 10-6. Existing Conditions at Primary Candidate Portal Sites on the Unocal Corridor

Candidate Site	Adjacent Land Use	Topography	Site Specific Comment	Existing Noise/Vibration Sources
Portal 3				
D	Rural residential with commercial to the north	Gentle slope	Some trees, grass and houses	Local traffic along Edmonds Way
E	Rural residential with commercial to the north	Gentle slope. Located in a depression	Some trees, grass and houses	Local traffic along Edmonds Way
F	Rural residential	Depression	Forested with blackberry bushes and trees to the north, east, and west	Minimal residential traffic
Portal 7				
A	Residential, school to the north	Gentle uphill to the north/northeast	Ball field with tall conifer trees on south and east side of site. King County shop to the west	Local traffic from 25th Ave. NE
B	Residential, school to the northeast, ball field to the east, bog and park to the north	Gentle uphill to northeast	Few trees, King County shop, buildings, open area	Local traffic from 25th Ave. NE and Ballinger Way NE
C	Residential with some trees, school to the northeast, ball field to the east, King County shop to the south	Gentle uphill to northeast	Some trees, some grass, part of site is in a park and apparent bog	Local traffic from 25th Ave. NE
Portal 11				
A	Light industrial and commercial uses, retail/business north of NE Bothell Way	Located in a low area on a gentle slope uphill to the north	Area with commercial and light industrial buildings and no trees, trucks in the area	Commercial (heavy, e.g., truck) traffic and local traffic along Bothell Way and Juanita Dr. NE; seaplanes
B	Light industrial and commercial uses, retail/business north of NE Bothell Way	Located in a low area on a gentle slope uphill to the north	Area with commercial and light industrial buildings and no trees, trucks in the area	Commercial (heavy, e.g., truck) traffic and local traffic along Bothell Way and Juanita Dr. NE; seaplanes
C	Urban commercial area surrounds site with residential area to northwest	Gentle slope uphill to the northwest	Parking lot with buildings on the north and east side and a few trees along the southwest and southeast	Local traffic from 68th Ave. NE and NE 181st St.; seaplanes

Table 10-6. Existing Conditions at Primary Candidate Portal Sites on the Unocal Corridor (cont.)

Candidate Site	Adjacent Land Use	Topography	Site Specific Comment	Existing Noise/Vibration Sources
Portal 14				
A	Office park	Level	Sports/ball field with floodlights and paved pedestrian trail around the complex	Commercial traffic along North Creek Parkway
B	Office park	Level	Sports/ball field with floodlights and paved pedestrian trail around the complex	Commercial traffic along North Creek Parkway
D	Office park	Moderate uphill to the east	Open grassy area in a bowl, few trees on perimeter, foot trails and benches	Commercial traffic along 120th Ave NE

10.2.3.3 Outfall: Unocal

Major existing noise sources in the vicinity of the outfall zones were identified; however, noise levels were not monitored. Major existing noise sources near Zone 6 in Edmonds include the BNSF railroad line, ferry traffic at the Edmonds Ferry Terminal, and roadway traffic from SR-104. Boat traffic on Puget Sound is also an occasional source of noise.

10.3 Impacts and Mitigation

10.3.1 Impacts and Mitigation Common to All Systems

10.3.1.1 Construction Impacts Common to All Systems

Noise Impacts Common to All Systems

Noise generated by construction equipment would be experienced by nearby receptors while treatment, conveyance, and outfall facilities are being built. Table 10-7 shows unmitigated maximum noise levels from commonly used construction equipment.

Table 10-7. Expected Construction Equipment and Maximum Noise Levels

Type of Equipment	Rating or Capacity	Engine Size (Horsepower)	Range of Maximum Sound Level at 50 feet (dBA)
Crawler tractor / dozer	101 to 250 hp	101 to 250	81 to 85
	251 to 700 hp	251 to 700	85 to 90
Front end loader	2-1/4 to 5 cu yd	116 to 299	82 to 86
	6 to 15 cu yd	300 to 750	86 to 90
Hydraulic backhoe excavator	1-1/2 to 3 cu yd	131 to 335	82 to 86
	3-1/4 to 7 cu yd	336 to 760	86 to 90
Grader	9 to 16 ft blade	60 to 350	79 to 86
Mobile crane	11 to 75 ton at 10 ft boom	121 to 240	82 to 85
Pile driver (impact)	not specified	not specified	101
Pile driver (sonic or vibratory)	not specified	not specified	96
Portable air compressor	400 to 2000 cfm at 100 psi	126 to 600	82 to 89
Trucks	100 to 400 hp	100 to 400	81 to 87

Source: Bolt, Beranek, and Newman, Inc. (1981)

At distances beyond 50 feet, these maximum noise levels would be reduced 5 to 7 dBA for each doubling of the distance between the noise source and the receiver. For example, a hydraulic backhoe excavator of 7-cubic-yard capacity and 760 horsepower could generate noise levels 79 to 85 dBA at a distance of 100 feet. The actual noise reduction would depend on effects of terrain and line-of-sight barriers such as berms, retaining walls, opaque fences, and buildings.

Truck traffic during construction would also have the potential to cause increased noise levels at receptors along the construction access and haul routes. Impacts specific to each site are discussed in the sections below.

The range of maximum sound levels from the construction equipment at a distance of 50 feet exceeds regulated noise levels in all jurisdictions; however, as noted above in the Regulatory Environment section, construction activities during daytime hours on weekdays are exempt from maximum noise levels in all jurisdictions within the project area. Traffic noise on public roads is also exempt from the maximum levels. However, King County has committed to measures that would reduce construction noise and minimize impacts on nearby residences and businesses. These measures are described below in Proposed Mitigation Measures Common to All Systems.

Vibration Impacts Common to All Systems

Some vibration would also occur as a result of the operation of heavy construction equipment. Table 10-8 shows representative levels of vibration likely to be experienced at a distance of 50 feet from each type of equipment. All of these vibration levels are at or above the "residential annoyance" level for infrequent events, as shown in Figure 10-1, and are also at or above the single-event maximum criteria level shown in Table 10-3 for residential structures subject to infrequent events. Noise and vibration levels are lower when vibratory or sonic-type pile-driving equipment, rather than impact-type equipment, is used for construction. Vibration impacts from tunneling operations would be attenuated due to the depth below the surface of the Brightwater tunnels and the type of soils along the proposed alignments.

Table 10-8. Expected Construction Equipment and Maximum Vibration Levels

Type of Equipment		Approximate Vibration Level at 50 feet (inch/sec RMS)
Pile driver (impact)	Upper range	0.200
	Typical	0.080
Pile driver (vibratory) or sonic	Upper range	0.090
	Typical	0.022
Large bulldozer		0.011
Loaded trucks		0.010

10.3.1.2 Operation Impacts Common to All Systems

Noise Impacts Common to All Systems

Conveyance system project operation noise levels at the property line of the residential receptors would not exceed the appropriate noise level limits of the applicable codes for residential land use in residential or rural zones. The above-ground conveyance facilities at select portals (primarily odor control facilities) would be designed to operate at noise levels at or below the applicable regulated nighttime noise levels of the respective jurisdictions at the nearest noise-sensitive receptor.

The following types of operational noise are associated with treatment facilities, pump stations and the above-ground facilities at portals:

- Noise from the operation of mechanical equipment, including pumps, blowers, fans, centrifuges, and cogeneration engine or turbine generators
- Noise from standby electrical generation equipment (e.g., backup generators for treatment facilities or pump stations during a power outage)
- Noise from electrical power substations
- Noise from water flowing over weirs
- Noise from routine operation and maintenance activities. These planned activities would typically occur for a short time (weeks) and during normal working hours
- Noise from emergency operation, maintenance, and repair activities. These are unanticipated conditions that may require nighttime work, and could pose significant noise impacts

The potential for these types of impacts is discussed below for the individual treatment plant sites.

Vibration Impacts Common to All Systems

Vibration can occur from the operation of mechanical equipment at treatment facilities and conveyance pump stations (Unocal Conveyance Alternative only). Based on the U.S. Department of Transportation (1998), a vibration velocity of 0.004 in/sec RMS (applicable to a Category 2 land use in Table 10-3), was chosen as the maximum acceptable vibration level applicable to residential receivers adjacent to treatment plant sites or the Unocal conveyance pump station site. Most types and sizes of mechanical equipment that will be used during operation of the Brightwater treatment and conveyance facilities are not capable of generating vibration at high enough levels to be detected at sensitive properties. Large (150 horsepower and larger) pumps, blowers, centrifuges, fans, and engine generators will be designed with the necessary vibration

isolation and damping foundations to reduce transmission of force to the supporting structures to levels below the threshold of human perception at the nearest residences.

10.3.1.3 Proposed Mitigation Common to All Systems

Noise Mitigation Common to All Systems

Construction Mitigation

Mitigation measures to reduce noise impacts, in addition to applicable local regulations, have been identified for implementation at the treatment plant sites if necessary to maintain noise levels within permissible limits. The following measures would be implemented at either treatment plant site:

- Vibratory or sonic pile driving will be implemented where feasible, as determined by soil conditions, to reduce noise impacts from impact pile driving.
- All construction equipment would be required to be equipped with well-maintained mufflers and other sound control devices comparable to or better than those originally supplied by the manufacturer.
- Noisy portable equipment, such as generators or compressors, would be located as far away from sensitive receptors as practical and muffled.
- Equipment would not be allowed to idle for long periods; equipment not being used would be shut off.
- Construction haul routes would be designated to minimize impacts on sensitive receptors.
- Specific noise level limits would be specified in construction contract documents for certain construction equipment, such as internal combustion engine-powered generators, compressors, excavators, loaders, and graders. Noise levels would be monitored during construction.
- Any construction activities required outside of exempt daytime hours would be conducted only under a variance. Applicable noise source land uses are industrial for the Route 9 site and commercial for the Unocal site.
- Damping material would be used on material haul truck beds.

Additional measures would be implemented to mitigate impacts to residential properties and public use areas near portal operations. These measures include establishing a 24-hour hotline for the public to express complaints about noise impacts and sending flyers to the community well in advance of construction to inform them about the project. Construction site noise barriers and building treatments to improve highly impacted

buildings' noise reduction capability could also be implemented as needed. In extreme cases, residents could be temporarily relocated if unmitigatable conditions persist.

Operation Mitigation

For mitigation of the conveyance system pump stations, all equipment would be housed in buildings and in below-ground galleries. Ventilation air intakes and exhausts of equipment rooms would be placed in a direction facing away from sensitive receivers whenever possible. Noise-reduction-rated acoustic louvers and duct silencers would be selected to reduce transmission of indoor noise to the outdoors.

Conveyance system noise sources, such as engines, fans, and blowers, would be designed with noise reductions to limit noise impacts. Also, pumps, blowers, centrifuges, fans, and engine generators would be designed with the necessary vibration isolation and damping foundations to reduce transmission of force to the supporting structures to levels below the threshold of human perception at the nearest residences. Pump station ventilation systems design would include attenuation of fan noise and pump and motor noise to meet the specified noise level limits.

Vibration Mitigation Common to All Systems

Construction Mitigation

Vibratory or sonic-type pile driving is the only practical mitigation available for pile driving and could reduce transmitted vibration to at least half of the levels resulting from impact pile driving (USDOT, 1998). Other construction activities with vibration impacts, such as excavation and truck movement, would have lower impacts than pile driving and can only be partially mitigated by limiting the time of day of occurrences and the proximity to sensitive structures on residential land uses.

Operation Mitigation

Because long-term vibration impacts from operation of conveyance facilities are expected to be negligible, mitigation would be needed only for operating pump stations and selected odor control facilities. The design measures listed above for operation noise mitigation would also mitigate for potential operational vibration impacts.

10.3.2 Impacts and Mitigation: Route 9 System

10.3.2.1 Treatment Plant: Route 9

Construction Impacts: Route 9 Treatment Plant

Noise Impacts

Truck traffic and site work during construction at the Route 9 site would result in temporary noise impacts to receptors near the site and along construction haul routes. The kinds of noise that might be expected during construction include the sounds of heavy earth moving, concrete trucks, dump trucks, cranes, and other types of heavy construction equipment. Sensitive residential receptors are located both east and west of the Route 9 site. The nearest residences to the east of the site are approximately 700 feet from the property line and are separated from the site by SR-522 and the BNSF railroad tracks. The closest residences to the west are approximately 100 feet from the property line, across SR-9. Construction noise levels at the nearest residences west of the site are likely to be a maximum of 83 to 85 dBA. Noise level reduction with distance could be greater, depending on the effects of terrain and line-of-sight barriers such as berms, retaining walls, and buildings.

Vibration Impacts

Vibration impacts during construction are discussed in the section titled Impacts and Mitigation Common to All Systems.

Operation Impacts: Route 9 Treatment Plant

Noise Impacts

The following types of operational noise are associated with treatment plants and/or pump stations:

- Noise from the operation of mechanical equipment, including pumps, blowers, fans, centrifuges, and cogeneration engine generators
- Noise from standby electrical generation equipment (e.g., backup generators for treatment facilities or pump stations during a power outage)
- Noise from electrical power substations
- Noise from water flowing over weirs

The noise generated by plant operations at the nearest noise-sensitive receptors to the Route 9 site would be no more than that allowed by the Snohomish County Code for the minimum nighttime period, which is 47 dBA at a residential land use receiving property in a rural zone, with the treatment plant land use being industrial. This is 2 dBA higher than the minimum ambient noise levels of 45 dBA measured at the site during nighttime hours.

Treatment plant noise would likely be masked by traffic noise from SR-522 and SR-9 much of the time. Although the change in noise levels may be perceptible under nighttime conditions, treatment plant noise sources with tonal qualities, such as engines, fans, and blowers, would be designed with noise reductions in the appropriate frequency bands to reduce tonal components of the spectrum to limited levels over the existing minimum hour ambient noise levels in the same frequency band as the tonal source. This would result in very low contributions of tonal sources to the overall noise level and difficulty in discerning the tone, even during the quietest nighttime periods.

Truck traffic resulting from chemical or other deliveries to the plant or hauling biosolids, grit, or screenings from the plant would be perceptible by residences along SR-9 from the plant exit to the interchange at SR-522. Operational truck noise impacts are expected to be minimal at posted speed limits, and would be only intermittent due to the relatively low number of trucks required for operation.

Vibration Impacts

Vibration impacts are discussed in Vibration Impacts Common to All Systems.

Proposed Mitigation: Route 9 Treatment Plant

Construction Mitigation

Construction mitigation measures for noise impacts at treatment plant sites are as described in Noise Mitigation Common to All Systems. Techniques for vibration control that apply to treatment plants as well as to conveyance are discussed in Vibration Mitigation Common to All Systems.

Operation Mitigation

Project operation noise levels at the property line of residential receptors would not exceed the appropriate noise level limits of the applicable codes for residential land use in a rural zone. The treatment plant would be designed to operate at noise levels at or below the applicable regulated nighttime noise levels of the respective jurisdictions at the nearest noise-sensitive receptor. For the Route 9 site, the limit is set at 47 dBA.

All equipment would be housed in buildings and in below-ground galleries. Water “fall” sound would be confined to covered structures such that this low-level sound could not contribute to the exterior noise level.

Ventilation air intakes and exhausts of equipment rooms would be placed in a direction facing away from sensitive receivers whenever possible. Noise-reduction-rated acoustic louvers and duct silencers would be selected to reduce transmission of indoor noise to the outdoors.

Noise sources with tonal qualities, such as engines, fans, and blowers, would be designed with noise reductions in the appropriate frequency bands to reduce tonal components of the spectrum to limited levels over the existing minimum hour ambient noise levels in the same frequency band as the tonal source. This would result in very low contribution of tonal sources to the overall noise level and difficulty in discerning the tone, even during the quietest nighttime periods. Also, large (150 hp and larger) pumps, blowers, centrifuges, fans, and engine generators would be designed with the necessary vibration isolation and damping foundations to reduce transmission of force to the supporting structures to levels below the threshold of human perception at the nearest residences. Influent pump station ventilation systems design would include attenuation of fan noise and pump and motor noise to meet the specified noise level limits.

Appendix 10-A, Noise and Vibration: Treatment Plant, presents octave frequency band noise levels representative of each treatment plant site's minimum hour ambient noise level, along with specific noise sources expected to contribute to operational noise at either site. The existing nighttime ambient spectrum shape would be preserved as much as possible with the overlay of treatment plant operational noise.

10.3.2.2 Route 9–195th Street Corridor

Construction Impacts: 195th Street Corridor

Noise Impacts

Sources of construction noise related to the conveyance facilities would be similar to those described previously in Impacts and Mitigation Common to All Systems. Noise from tunneling would occur at portal locations. No noise would be detectable in the areas between the portals because construction operations would be at such depths that generated noise would be attenuated by the soil between the tunnel and the ground surface. Similarly, for microtunneling construction noise would be limited to the microtunneling pits.

Any open-cut construction would generate noise in the immediate vicinity of pipe installation operations. Maximum noise levels at a distance of 50 feet from the construction equipment are shown in Table 10-7.

Microtunnel pits or open-cut trenches may be constructed in the vicinity of Portal Siting Areas 44, 41, and 11 to install connections between existing King County conveyance pipes to the new influent tunnel. Also, open-cut trenches or microtunneling would be used to construct the safety relief point to the Sammamish River. Noise impacts would be

similar to those described at the tunneling portals; however, the magnitude and duration of impacts would be less because microtunneling and open-cut activities are faster and the construction areas are smaller.

In general, in all jurisdictions, construction noise is exempt from maximum permissible levels during daytime hours, although the actual hours vary among jurisdictions. When work is to be performed outside the allowable hours, a request for variance from noise regulations would be required for the extended work hours.

Construction activities at the portal sites would involve the following sequential activities: construction of the portal, launching tunneling/microtunneling equipment, tunneling/microtunneling, recovery of tunneling/microtunneling equipment, local connections, and construction of permanent facilities.

Receptors and sensitive receptors likely to have noise and vibration impacts from both construction and operation and maintenance activities within the affected environment for each candidate portal site have also been identified, and are presented in Appendix 10-B, Noise and Vibration: Conveyance. Table 10-9 shows the relative sensitivity of each portal and site in this alternative. Secondary portals are included in Appendix 10-B, Noise and Vibration: Conveyance.

Table 10-9. Sensitivity to Noise in the Vicinity of Primary Portal Siting Areas on the Route 9–195th Street Corridor

Primary Portal Siting Area	Portal Vicinity	Candidate Portal Site	Sensitivity to Noise (High, Medium, Low)
11	NE 175th St. and 68th Ave. NE	Site 11-A	Low
		Site 11-B	Low
		Site 11-C	Medium
41	NE 195th St. and 120th Ave. NE	Site 41-A	Low
		Site 41-C	Medium
		Site 41-D	Medium
		Site 41-X	Low
		Site 41-W	Medium
		Site 41-J	Medium
44	NE 195th St. and 80th Ave. NE	Site 44-C	Medium
		Site 44-D	Medium
		Site 44-E	High
5	NE 205th St. and Ballinger Way NE	Site 5-B	Low
		Site 5-G	Low
		Site 5-X	Low
19	NW 205th St. and Richmond Beach Dr NW	Site 19-C	Low

Notes:
Low – would not require mitigation
Medium – require some mitigation measures
High – potential for extensive mitigation

Portals located within densely developed residential areas have the potential to affect more residential receptors than portals in undeveloped areas. (Refer to Chapter 11 for a discussion of the relative density of development within portal siting areas.) Construction would occur as many hours per day as possible (up to 24 hours) in accordance with local jurisdictions' regulations. Individuals working night shifts or needing to sleep during daytime hours would be the most negatively affected by the construction noise. A hypothetical two-acre conveyance tunnel portal site with projected maximum construction noise levels is shown in Figure 10-5. Noise levels during peak construction activities could reach as high as 76 dBA at distances of 250 feet from the construction area. Trucks entering and exiting the portal sites would generate noise levels as high as 90 dBA at 50 feet. These levels could temporarily disrupt outdoor conversation and other outdoor activities in areas immediately adjacent to the construction site.

In general, the impacts of conveyance construction noise on any specific receptor would be of shorter duration than for receptors near the treatment plants, but could be expected to last from 1 to 4 years at portal sites, and up to 3 years at pump station locations. In selecting final portal sites, efforts will be made to avoid sensitive receptors and immediately adjacent residences.

In addition to the sensitivity of the nearby receptors listed in Table 10-9, the length of the construction period will also influence the degree of noise impacts at the portals. Construction activities at launching portals would last between 3 and 4 years compared with only 1.0 to 1.5 years at receiving portals. The durations include the construction of the portal itself, which will last about 6 months to 1 year. Table 10-10 summarizes the construction activities, construction methods, length of construction, and permanent facilities required for each Route 9–195th Street corridor alternative portal.

Vibration Impacts

Only three jurisdictions along the conveyance corridors have regulations governing vibration due to construction activities (see Appendix 10-B, Noise and Vibration: Conveyance). Vibration criteria based on experience from other cities and counties would be developed for use on the project. The contractor would be required to ensure that ground vibration does not exceed the magnitudes listed in the specifications prepared for the project. The vibration limits are established based on peak particle velocities. Vibration generated by a tunnel boring machine, either for a large-diameter tunnel or a microtunnel, would be attenuated by the soil between the tunnel and the ground surface, depending on soil types and distance to sensitive receptors.

Vibration impacts during tunneling are not anticipated because of the depth of tunneling and the soil characteristics along the alignment. Most vibration impacts at the portals will occur during the initial phase of the portal construction. Temporary vibration impacts could potentially occur at the portals that would be constructed using sheet piles. Sheet pile construction could be used at Portals 11 and 19 for the Route 9–195th Street alternatives (Table 10-10). Both portals are located in industrial/commercial areas. The

remaining portals (5, 44, and 41) would be constructed by methods that are not anticipated to have vibration impacts, such as concrete slurry walls or jet grouting.

Table 10-10. Primary Portal Construction Methods and Permanent Facilities on the Route 9–195th Street Corridor

Portal	Construction Activity	Possible Portal Construction Method	Construction Duration (years)	Permanent Aboveground Facilities
11	Launching portal	Interlocking steel-sheet pile walls	2.0-2.5	Odor Control Facility
44	Launching and receiving portal	Concrete slurry walls with a jet-grout invert slab	3.5-4.0	Odor Control Facility
41	Launching portal	Concrete slurry walls installed into impermeable soils below invert	3.0	Odor Control Facility (IPS Optional)
5	Receiving portal	Concrete caisson construction or concrete slurry walls installed to depth of approximately 75 ft, excavation in the wet or dry to this depth, followed by sequential excavation and concrete lining to full depth.	1.0	Odor Control Facility Dechlorination Facility
19	Launching portal	Interlocking steel-sheet pile walls, with a jet grout invert plug	3.5-4.0	None

Portal 41 Influent Pump Station Option

Impacts related to construction of the IPS at Portal 41 are similar to those identified for portal construction. However, with the increased level of construction activity at the site, both noise and vibration impacts can be expected to be locally greater, particularly during peak construction periods. In general, the impacts of construction noise on specific receptors could be expected to last up to 2 years for construction of the IPS; however, the overall construction at Portal 41 is expected to last approximately 3 years.

Operation Impacts: 195th Street Corridor

There would be no long-term sources of noise or vibration at portals and pits restored to preexisting conditions or converted to tunnel access facilities. Where passive odor control systems (without ventilation fans) are applied, no noise control would be required. Otherwise, odor control facilities would be provided with noise reduction similar to

treatment plants as required to conform to the permissible noise levels of the applicable jurisdiction. Pipelines within the gravity tunnels would not create any noise or vibration impacts.

Mechanical equipment and backup generators are the major noise and vibration sources during operations of a pump station. Noise impacts are expected to be minimal because all equipment and operations would be housed in structures, designed with sound attenuating materials and equipment secured with vibration isolation features.

Proposed Mitigation: 195th Street Corridor

Construction Mitigation

Mitigation measures described in the section titled Impacts and Mitigation Common to All Systems would be applied to construction equipment at portals to minimize noise impacts to sensitive receptors adjacent to construction areas. In portal siting areas located immediately adjacent to residential areas, additional mitigation may be needed during peak construction periods. Such measures would be implemented according to requirements of the local jurisdiction.

Open-cut construction for connection to the portals is not expected to have any major noise or vibration impacts. Vibration impacts on residences would depend on the age of the residence and its proximity to the construction.

Operation Mitigation

Because long-term noise and vibration from operation of conveyance facilities is expected to be minimal, mitigation should be needed only for operating pump stations and selected odor control facilities. However, if measures are required, mitigation measures described previously in Impacts and Mitigation Common to All Systems for the treatment plant sites would be applied to conveyance facilities as well to minimize noise impacts to sensitive receptors along the selected conveyance route.

10.3.2.3 Route 9–228th Street Corridor

Construction and Operation Impacts: 228th Street Corridor

The discussion presented in the section titled Impacts and Mitigation: Route 9 System for the 195th Street corridor also applies to the 228th Street corridor.

Receptors and sensitive receptors likely to have noise and vibration impacts from both construction and operation and maintenance activities within the affected environment for

each candidate portal site have been identified, and are presented in Appendix 10-B, Noise and Vibration: Conveyance. Table 10-11 shows the relative sensitivity of each primary portal and site in this alternative. Secondary portals are listed in Chapter 3 and discussed in Appendix 10-B, Noise and Vibration: Conveyance.

Table 10-11. Sensitivity to Noise in the Vicinity of Primary Portal Siting Areas on the Route 9–228th Street Corridor

Portal Siting Area	Portal Vicinity	Candidate Portal Site	Sensitivity to Noise (High, Medium, Low)
11	Same as Route 9–195th Street Corridor		
41	Same as Route 9–195th Street Corridor		
44	Same as Route 9–195th Street Corridor		
39	228th St. SE and 31st Ave. SE	Site 39-B	Medium
		Site 39-C	Medium
		Site 39-D	Medium
33	228th St. SW and Locust Way	Site 33-A	Medium
		Site 33-C	Medium
		Site 33-D	Medium
26	228th St. SW and Lakeview Dr.	Site 26-A	Medium
		Site 26-C	Medium
		Site 26-D	High
19	NW 205th St. and Richmond Beach Dr. NW	Site 19-C	Low

Notes:
Low – would not require mitigation
Medium – require some mitigation measures
High – potential for extensive mitigation

In addition to the sensitivity of the nearby receptors listed in Table 10-11, the length of construction period would also influence the degree of noise impacts at the portals. Construction activities at launching portals would last between 2.5 and 4 years compared with only 1.0 to 1.5 years at the recovery portal. Table 10-12 summarizes the construction activities, construction methods, length of construction, and the permanent facilities required for each primary portal for the Route 9–228th corridor alternative (west to east).

Table 10-12. Primary Portal Construction Methods and Permanent Facilities on the Route 9–228th Street Corridor

Portal	Construction Activity	Possible Portal Construction Method	Construction Duration (years)	Permanent Aboveground Facilities
11	Launching portal	Interlocking steel-sheet pile walls	2.0-2.5	Odor Control Facility
44	Launching and recovery portal	Concrete slurry walls with a jet-grout invert slab	3.0-3.5	Odor Control Facility
41	Launching and recovery portal	Concrete slurry walls installed into impermeable soils below invert	2.5-3.0	Odor Control Facility (IPS Optional)
39	Launching and recovery portal	Concrete slurry walls installed into impermeable soils below invert	3.0	None
33	Launching and recovery portal	Concrete slurry walls installed into impermeable soils below invert	3.0-3.5	None
26	Recovery portal	Ground freezing	1.0	Dechlorination Facility Odor Control Facility
19	Launching portal	Interlocking steel-sheet pile walls, with a jet grout invert plug	3.5	None

10.3.2.4 Outfall: Route 9

Construction Impacts: Route 9 Outfall

A temporary increase in noise levels would occur in the vicinity of the staging area and outfall pipeline alignments. Depending on the types of land construction machinery being used, noise levels could range from 79 to 90 dBA at a distance of 50 feet based on the data shown in Table 10-7. Noise levels are also likely to increase along truck routes during construction of the outfall. Traffic impacts are discussed in Chapter 16.

In-water outfall construction would take place from the shoreline, along a portion of the outfall alignments, and up to approximately 5,200 feet offshore. Noise at the shoreline due to nearshore trench construction activities would range from 79 dBA to 90 dBA at a distance of 50 feet from the construction noise and would decrease with increasing distance of the construction equipment from the shoreline. Installation of sheet piles

would also produce noise and vibration. Offshore construction activities should not significantly increase background noise levels at the shoreline because of the distance offshore.

On-land and nearshore trench construction would occur during normal daylight working hours. Some potential offshore pipeline installation methods may require continuous (24 hours a day) construction at certain times.

Sheet pile driving onshore and at nearshore locations will be done during the day within the permitted hours, limiting both vibration and noise impacts. However, if sheetpile driving could cause damage to any sensitive structures, sheetpiles will be required to be installed by pre-augering. Since sheetpile installation by pre-augering is both time consuming and expensive, its use would need to be limited.

Operation Impacts: Route 9 Outfall

Operation of the Brightwater System outfall would not generate noise that could be heard by sensitive receptors on land, nor would it disturb sensitive receptors on the water, such as recreational boaters on Puget Sound.

Proposed Mitigation: Route 9 Outfall

Construction Mitigation

The following mitigation measures would be implemented during construction of the outfall:

- Vibratory or sonic pile drivers will be used where feasible to reduce noise impacts associated with impact pile drivers.
- All equipment would be required to have well-maintained mufflers and other sound control devices comparable to or better than those originally supplied by the manufacturer.
- Noisy portable equipment, such as generators or compressors, would be located as far away from sensitive receptors as practical.
- Equipment would not be allowed to idle for long periods; equipment not being used would be shut off.
- Construction haul routes would be designated to minimize impacts on sensitive receptors.

Operation Mitigation

No mitigation of noise and vibration would be necessary for outfall operation.

10.3.3 Impacts and Mitigation: Unocal System

10.3.3.1 Treatment Plant: Unocal

Construction Impacts: Unocal Treatment Plant

Noise Impacts

Truck traffic and site work during construction at the Unocal site would result in temporary noise impacts to receptors near the site and along construction haul routes. The kinds of noise that might be expected during construction include the sounds of heavy earth moving, pile driving, concrete trucks, dump trucks, cranes, and other types of heavy construction equipment. The nearest sensitive receptors to the Unocal site are residences near monitoring locations NML-1 and NML-3 (Figure 10-4). The closest residence is approximately 130 feet south of NML-1. At a distance of 50 feet, construction trucks can generate maximum noise levels of 81 to 87 dBA, and other types of equipment can produce levels of up to 90 dBA. Maximum noise levels shown in Table 10-7 would be reduced 5 to 7 dBA per doubling of distance beyond 50 feet or would be increased 5 to 7 dBA per halving of distance from the base 50 feet; thus, noise levels at the nearest residences are likely to be a maximum of 81 to 83 dBA. Noise level reduction with distance could be greater, depending on the effects of terrain and line-of-sight barriers such as berms, retaining walls, and buildings.

Other land uses adjacent to the Unocal treatment plant site include the marina and port properties (commercial waterfront) to the west and a public park, east of the site. Buildings on the commercial waterfront zone could be within 200-feet of treatment plant construction and could be subject to maximum intermittent exterior noise levels of 78 dBA. The public park land is approximately 600-feet from treatment plant site construction and could be subject to maximum intermittent noise levels of 68 dBA. The expected construction noise levels would be significantly above the existing daytime ambient noise levels (48 dBA, L50), and could be audible inside buildings on the commercial waterfront. Although maximum noise levels outside of marina and port buildings may be intermittently distracting and could interfere with normal verbal communication, noise levels inside of buildings are not likely to affect communication or the commercial office use of those buildings. Maximum noise levels at the public park could discourage people from using the park intermittently during peak construction periods.

Vibration Impacts

Table 10-8 shows the maximum expected vibration levels at 50 feet from construction equipment that would produce the highest vibration energy. As discussed in Impacts and Mitigation Common to All Systems, pile driving vibration levels could be at or above the "residential annoyance" level for infrequent events. Noise and vibration levels are lower when vibratory or sonic-type pile-driving equipment, rather than impact-type equipment, is used for construction. Techniques for vibration control that apply to treatment plants as well as to conveyance are discussed in Appendix 10-B, Noise and Vibration: Conveyance.

Operation Impacts: Unocal Treatment Plant

Noise Impacts

Refer to Operation Impacts: Route 9 Treatment Plant for a list of the types of operational noise associated with treatment plants and/or pump stations. During daytime hours (7 a.m. to 10 p.m.), treatment plant operations are not expected to result in an increase in existing noise levels at the nearest noise-sensitive receptors (residences near the Woodway and Fish Hatchery noise monitoring locations NML-1 and NML-3). This is based on treatment plant operating noise level mitigated to 39 dBA, which would limit the nighttime minimum ambient noise level increase to 5 dBA. Existing ambient daytime noise levels were measured at 48 dBA, which should completely mask the 39 dBA treatment plant contribution. Nighttime operational noise could increase the existing minimum ambient noise levels at these receptors by up to 5 dBA, which is a perceptible increase to most people. However, the higher noise level still would not exceed the regulated levels applicable to residential land use from commercial land use sources under the Edmonds Municipal Code, which sets a maximum of 50 dBA during the nighttime hours.

Truck traffic resulting from receiving chemicals or other deliveries at the plant or hauling biosolids, grit, or screenings from the plant would impact residences along Pine Street. The impacts should be minimal, due to existing posted speed limits, but would intermittently be noticeable to the residences along Pine Street. The number of truck trips and their traffic impacts are discussed in Chapter 16.

Unocal 72-mgd Sub-Alternative

Noise impacts from the 72-million-gallons-per-day (mgd) treatment plant would be 1 to 2 dBA greater than from the 54-mgd plant due to the increased number of process units and energy input. The additional contributing noise sources would be minor and farther from the sensitive receptors than the initial phase process equipment and, therefore, likely would not impact offsite receptors.

Unocal Structural Lid Sub-Alternative

Noise impacts of a lidded plant would depend upon the operational characteristics of the Edmonds Crossing. A noise impact evaluation for the Edmonds Crossing facilities would be completed as part of that project, which would be integrated with the Unocal structural lid sub-alternative. Noise impacts from the multimodal facility are described in the Edmonds Crossing Draft EIS, *SR 104 Edmonds Crossing Connecting Ferries, Buses, and Rail, Draft Environmental Impact Statement and Draft 4(f) Evaluation* (FHWA, 1998).

Vibration Impacts

Vibration can occur from the operation of mechanical equipment at treatment plants and pump stations. A vibration velocity of 0.004 inch/sec RMS was chosen as the maximum acceptable level for the Unocal site, and would not be exceeded. See the discussion in Impacts and Mitigation: Route 9 System.

Proposed Mitigation: Unocal Treatment Plant

Construction Mitigation

Construction mitigation measures for treatment plant sites are the same as those described in the section titled Impacts and Mitigation Common to All Systems. Some specific techniques for vibration control, which apply to treatment plants as well as to conveyance, are discussed in Appendix 10-B, Noise and Vibration: Conveyance. Pile driving will be done during the day within the permitted hours, limiting both vibration and noise impacts.

Operation Mitigation

Project operation noise levels at the property line of the residential receptors would not exceed the appropriate noise level limits of the applicable codes for residential land use. The treatment plant would be designed to operate at noise levels at or below the applicable regulated nighttime noise levels of the respective jurisdictions at the nearest noise-sensitive receptor and not more than 5 dBA above the minimum ambient nighttime noise level, whichever is lower. For the Unocal site, the limit is set at 39 dBA, which is 5 dBA above the minimum ambient noise level at the nearest residential land use, without contribution of wind in the trees.

Specific measures taken to control operational noise and vibration would be similar to those described for the Route 9 site. See the discussion in Proposed Mitigation: Route 9 System.

10.3.3.2 Conveyance: Unocal

Construction Impacts: Unocal Conveyance

Noise Impacts

The discussion in Impacts and Mitigation: Route 9 System for the 195th Street corridor also applies to the Unocal conveyance system. Table 10-13 shows the relative sensitivity to noise of each portal and site in this alternative. Secondary portals are included in Appendix 10-B, Noise and Vibration: Conveyance.

Table 10-13. Sensitivity to Noise in the Vicinity of Primary Portal Siting Areas on the Unocal Corridor

Portal Siting Area	Portal Vicinity	Candidate Portal Site	Sensitivity to Noise (High, Medium, Low)
3	SR 104 and 232nd St SW	Site 3-D	Medium
		Site 3-E	Medium
		Site 3-F	Medium
7	Ballinger Way NE and 25th Ave NE	Site 7-A	Medium
		Site 7-B	Medium
		Site 7-C	Medium
11	NE 175th St and 68th Ave NE	Site 11-A	Low
		Site 11-B	Low
		Site 11-C	Medium
14	North Creek Pkwy and 120th Ave NE	Site 14-A	Medium
		Site 14-B	Medium
		Site 14-D	Medium

Notes:
Low – would not require mitigation
Medium – require some mitigation measures
High – potential for extensive mitigation

Portal Siting Area 11, where a pump station would be constructed, is located in an industrial area adjacent to Kenmore Air Harbor and SR-522, both of which are significant noise generators. Noise increases from conveyance facility construction would not likely affect residences north of SR-522.

Vibration Impacts

Table 10-14 summarizes the construction activities, construction methods, construction duration, and the permanent facilities required for the Unocal System.

Table 10-14. Primary Portal Construction Methods and Permanent Facilities on the Unocal Corridor

Portal	Construction Activity	Possible Portal Construction Method	Construction Duration (years)	Permanent Facilities
3	Launching portal	Ground freezing	1.0	None
7	Recovery portal	Concrete slurry walls	3.0	Odor Control Facility
11	Launching portal	Sheet piles	3.5-4.0	Odor Control Facility Pump Station
14	Recovery portal	Sheet piles	1.0	Odor Control Facility

Vibration impacts during tunneling are not anticipated because of the depth of tunneling and the soil characteristics along the alignment. Temporary vibration impacts could potentially occur at the portals that would be constructed using sheet piles. Sheet pile construction could be used at Portals 11 and 14 for the Unocal conveyance alternative (Table 10-14). Portal construction will take approximately 6 months to 1 year. Both portals are located in industrial/commercial areas. The remaining portals (3 and 7) would be constructed by methods that are not anticipated to have vibration impacts, such as concrete slurry walls or ground freezing.

Operation Impacts: Unocal Conveyance

Additional sources of noise during operation would be mechanical equipment and backup generators used at the pump station at Portal Siting Area 11. As with the treatment plant, noise attenuating measures would be incorporated into pump station design to restrict noise levels at the property line of the nearest noise sensitive receptor to 50 dBA, the maximum nighttime noise level allowed by the City of Kenmore for industrial land use sources. Vibration impacts from operation of the pump station and force mains would be the same as those described in the treatment plant and conveyance system operations sections.

Proposed Mitigation: Unocal Conveyance

Construction and operation mitigation techniques are essentially the same for all of the conveyance corridor alternatives. See the discussion under Impacts and Mitigation: Route 9 System.

Some of the sites would have open-cut construction for connection to the portals, but these are not expected to have any major noise or vibration impacts. Vibration impacts to

residences would depend on the age of the residence and its proximity to the construction.

10.3.3.3 Outfall: Unocal

The outfall impacts and mitigation for the Unocal System are the same as those for the Route 9 System, as discussed in the section titled Impacts and Mitigation: Route 9 System.

10.3.4 Impacts: No Action Alternative

Noise levels would remain unchanged as a result of implementation of the No Action Alternative. There would be no construction or operation of the treatment plant and existing noise levels would remain the same in the area, or increase, depending on the development that eventually occurs on the sites. Increased noise and vibration impacts may result in the areas of South Treatment Plant and the West Point Treatment Plant from the need to expand those facilities.

10.3.5 Cumulative Impacts

Construction noise at either treatment plant site and at portals would contribute to overall noise increases accompanying urbanization in the region. If construction of the Brightwater Treatment Plant at the Unocal site were to take place at the same time as construction of the Edmonds Crossing multimodal facility, cumulative noise from the two projects would be higher at nearby receptors than at either facility alone. Noise levels during operation of the two facilities would also be higher, primarily as a result of multimodal traffic using the Edmonds Crossing facility because the treatment plant operational noise level would be mitigated to low levels for low nighttime impact. However, the Edmonds Crossing facility is a public transportation element and is not regulated for noise levels under Ecology regulations. Related traffic noise impacts are therefore considered separately from the treatment plant (see Chapter 16).

The treatment plant regulated noise level limits are specified without any credit or debit from other noise sources not in the control of the treatment plant. The treatment plant operational noise design criteria for the Unocal site are below regulated limits because of the existing minimum hour low level ambient noise at that site.

10.4 Significant Unavoidable Adverse Impacts

Construction activities at the treatment plant site and at the portal siting areas would cause unavoidable temporary increases in nearby noise levels and along local haul routes because of the limitations of practical mitigation. In some cases, these impacts may be locally significant due to close proximity to sensitive land use, particularly during peak construction periods. Significant impacts would apply to residences that are nearest to construction haul routes or nearest to construction activities on a Brightwater System site. Construction noise mitigation would apply primarily to those nearest residences. The significant impacts would be those associated with peak noise levels of single-event type noise sources of short duration, such as truck pass-by or pile driving. Impacts could include speech (conversation) interference, sleep disturbance, and annoyance.

There would be no significant unavoidable adverse noise or vibration impacts from Brightwater facilities operation.

10.5 Summary of Impacts and Mitigation

Table 10-15 summarizes potential noise and vibration impacts and mitigation measures for the Brightwater System alternatives.

Table 10-15. Summary of Potential Noise and Vibration Impacts and Proposed Mitigation for Brightwater Systems

System	System Component	Impacts	Proposed Mitigation
Common to All Systems	Treatment Plant	Construction • Construction noise impacts would be up to 17 dBA over existing daytime ambient maximum noise levels. • Variances would be required for work outside exempt hours. • Some vibration would result from operation of heavy construction equipment (less for Route 9 than for Unocal).	Construction • Construction would be scheduled to occur during daytime hours to the extent feasible. Any construction activities required outside of exempt daytime hours would be conducted only under variance. • All construction equipment would be required to be equipped with well-maintained mufflers and other sound control devices comparable to or better than those originally supplied by the manufacturer. • Noisy portable equipment, such as generators or compressors, would be located as far away from sensitive receptors as practical and muffled. • Equipment would not be allowed to idle for long periods; equipment not being used would be shut off. • Construction haul routes would be designated to minimize impacts on sensitive receptors. • Specific noise level limits would be specified in construction contract documents for certain construction equipment, such as internal combustion engine-powered generators, compressors, excavators, loaders, and graders. Noise levels would be monitored. • Damping material would be used on material haul truck beds. • Vibratory or sonic pile driving would be implemented where feasible, depending on soil conditions.

Table 10-15. Summary of Potential Noise and Vibration Impacts and Proposed Mitigation for Brightwater Systems (cont.)

System	System Component	Impacts	Proposed Mitigation
Common to All Systems (cont.)	Treatment Plant (cont.)	Operation • Operations noise impacts would be a 5 dBA increase in the existing minimum hour ambient noise level, or would meet the applicable regulated nighttime noise level of the jurisdiction, whichever is lower, at the residence closest to the treatment plant site. • No operations vibration impacts are expected because equipment foundations design and isolation would mitigate transmitted vibration to levels below the human perception threshold.	Operation • Design equipment and facilities with noise and vibration attenuation. • Provide a buffer between the treatment plant and neighbors.
	Conveyance	Construction • Same as treatment plant; vibration impacts from tunneling operations would be attenuated due to the depth of the Brightwater tunnels and the type of soils along the proposed alignments. Operation • Same as treatment plant.	Construction • Same as treatment plant, plus the additional measures listed below. • Establish a 24-hour hotline for the public. • Send flyers to community in advance of construction. • Construct site noise barriers and/or install building treatments in highly impacted properties. • In extreme conditions, temporarily relocate residents if impacts cannot be mitigated. Operation • Same as treatment plant.
	Outfall Zones	Construction • Same as treatment plant. Operation • None.	Construction • Same as treatment plant. Operation • None.
Route 9–195th Street System	Treatment Plant	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.

Table 10-15. Summary of Potential Noise and Vibration Impacts and Proposed Mitigation for Brightwater Systems (cont.)

System	System Component	Impacts	Proposed Mitigation
Route 9–195th Street System (cont.)	Conveyance	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.
	Outfall	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.
Route 9–228th Street System	Treatment Plant	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.
	Conveyance	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.
	Outfall	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.
Unocal System	Treatment Plant	Construction • Percussion pile driving in the lower portion of the site would create noise and vibration impacts. • The lid construction could require longer construction days and a longer construction period.	Construction • Same as Common to All Systems, above.
		Operation • Same as Common to All Systems, above.	Operation • Same as Common to All Systems, above.

Table 10-15. Summary of Potential Noise and Vibration Impacts and Proposed Mitigation for Brightwater Systems (cont.)

System	System Component	Impacts	Proposed Mitigation
Unocal System (cont.)	Conveyance	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.
	Outfall	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.	Construction • Same as Common to All Systems, above. Operation • Same as Common to All Systems, above.
No Action Alternative	Treatment Plant	Construction • None. Operation • None.	Construction • None. Operation • None.
	Conveyance	Construction • None. Operation • None.	Construction • None. Operation • None.
	Outfall	Construction • None. Operation • None.	Construction • None. Operation • None.

10.6 References

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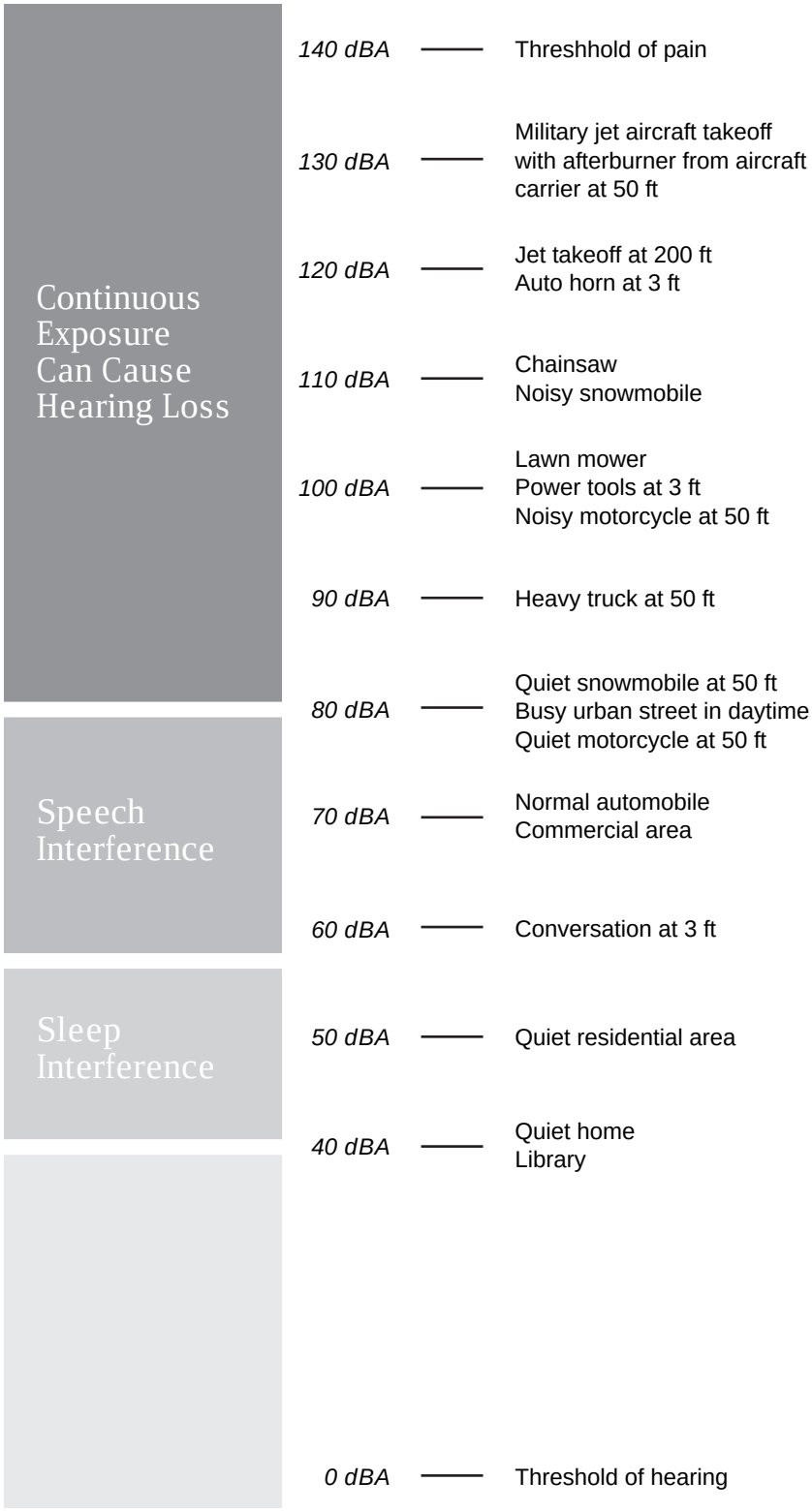
LIST OF FIGURES



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Data Sources: U.S. Department of Transportation, 1998
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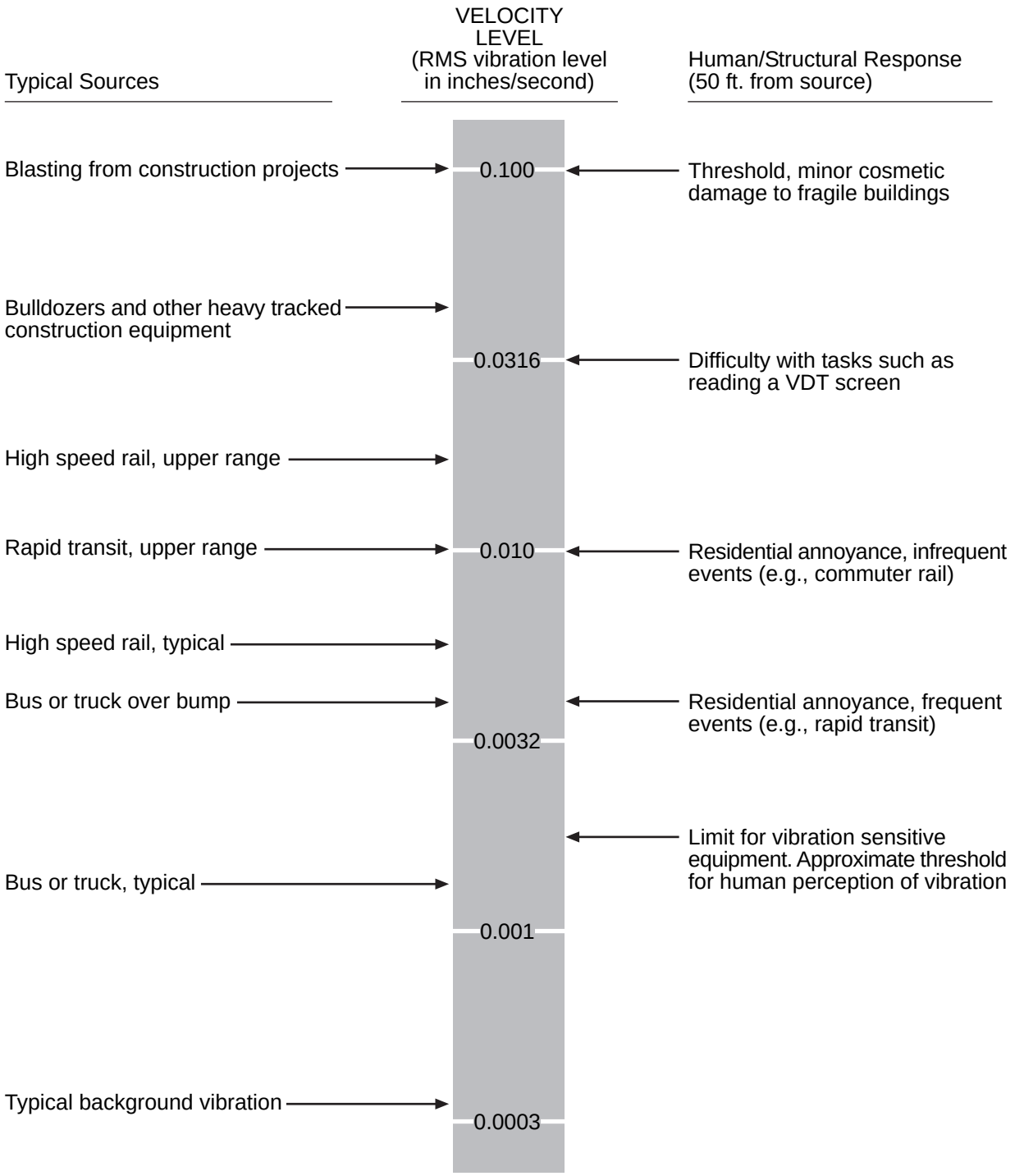
File Name: 157689.P3.EP.33_W072003002SEA • NOISE FIG 10-01_typical_sound_levels_v2 • 7/11/03 • dk

Figure 10-1
Typical Sound Levels
BRIGHTWATER FINAL EIS



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Data Sources: U.S. Department of Transportation, 1998
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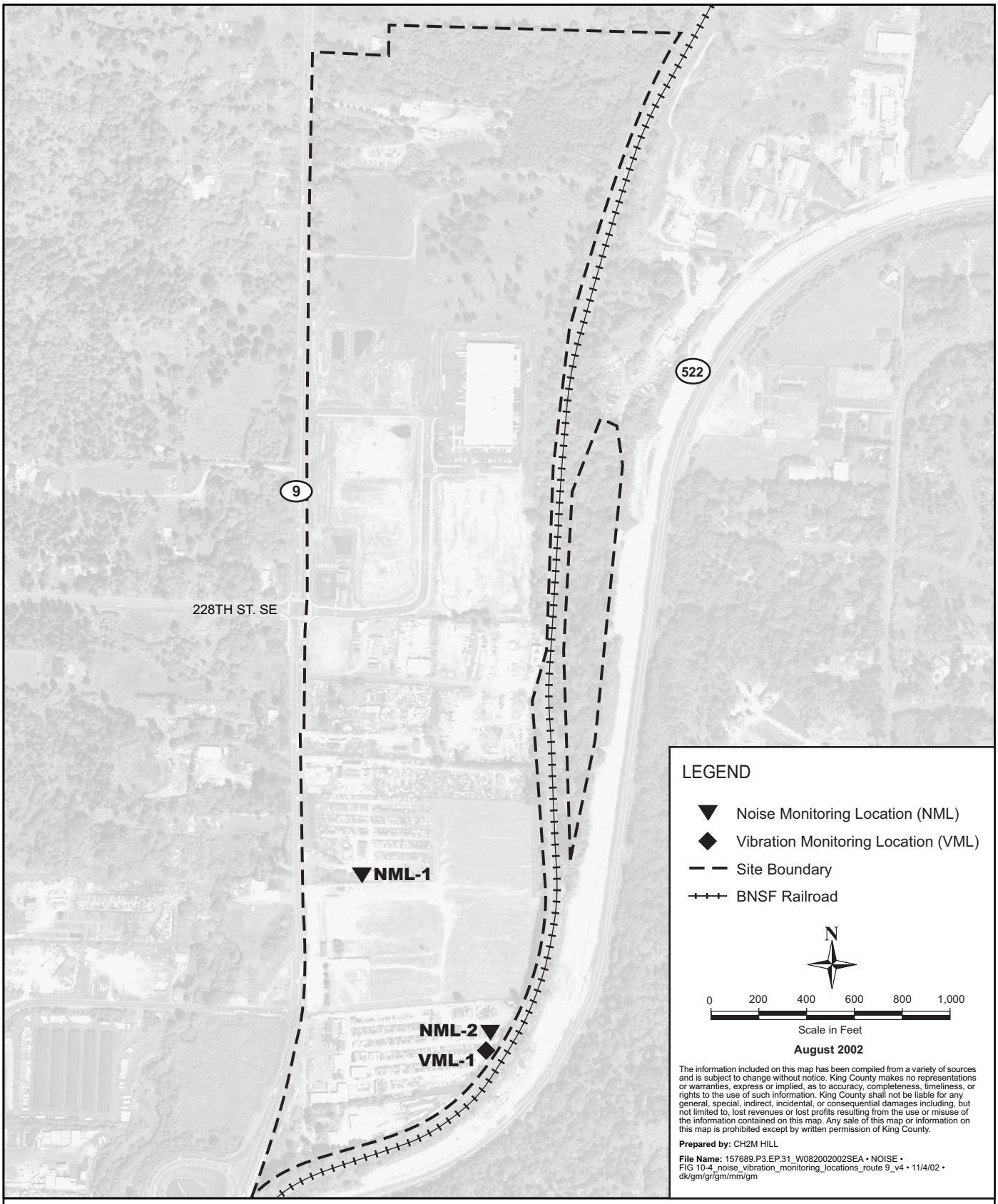
FIG 10-02_typ_levels_ground-borne_vibration_v3 • 10/24/02 • dk

Figure 10-2
Typical Levels of Ground-Borne Vibration
BRIGHTWATER FINAL EIS



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File Name: 157689.P3.EP.31_W082002002SEA • NOISE • FIG 10-4_noise_vibration_monitoring_locations_route 9_v4 • 11/4/02 • dk/gm/gr/gm/mm/gm

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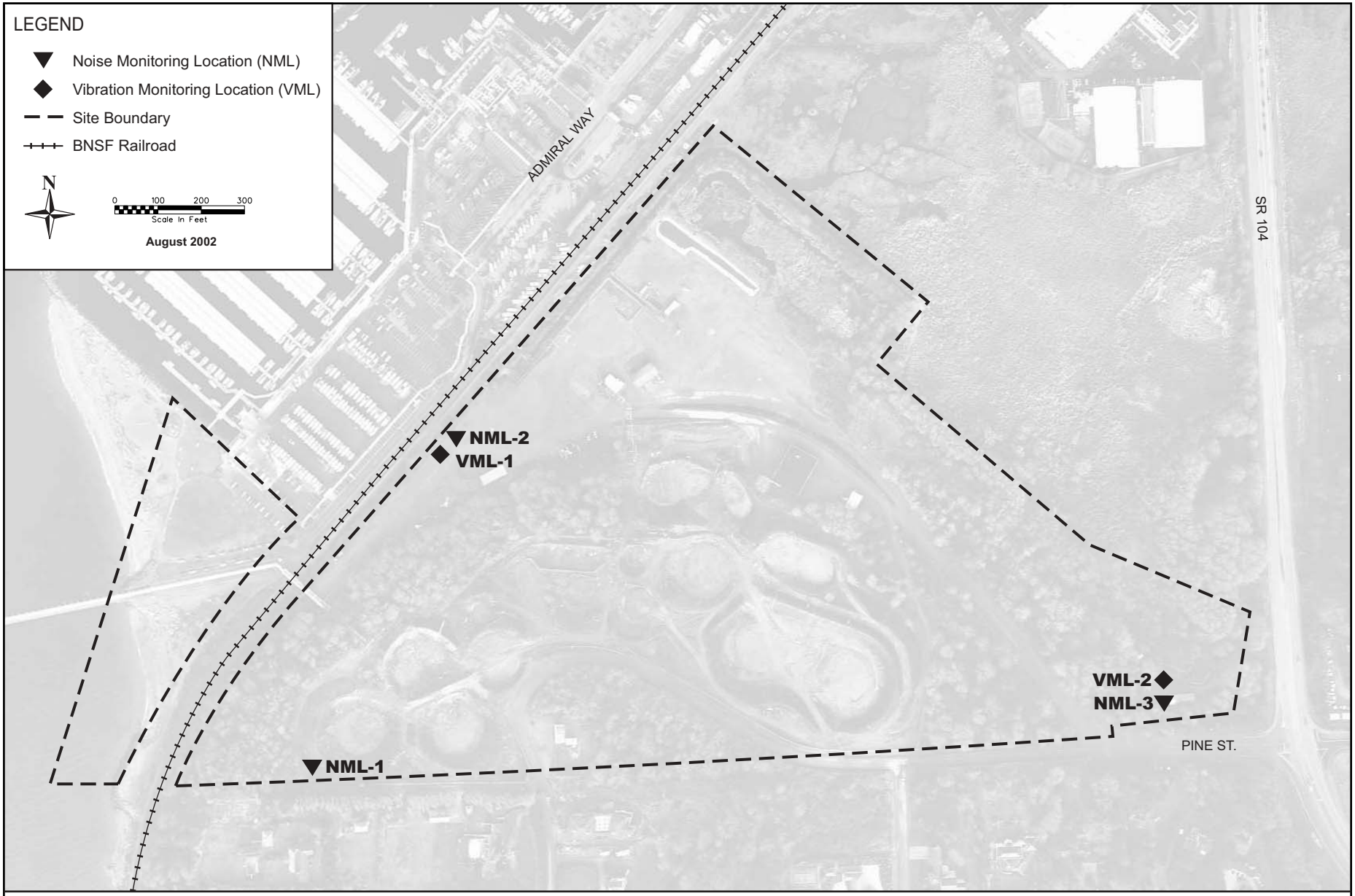
File Name: 157689.P3.EP.33_W072003002SEA • NOISE • FIG 10-03_noise_vibration_monitoring_locations_route_9_v4 • 9/15/03 • dk/lw

Figure 10-3

Noise and Vibration Monitoring Locations Route 9 Site

BRIGHTWATER FINAL EIS



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File Name: 157689.P3.EP.33_W072003002SEA • NOISE • FIG 10-04_noise_vibration_monitoring_locations_unocal_v2 • 7/11/02 • dk

Figure 10-4
Noise and Vibration Monitoring Locations Unocal Site
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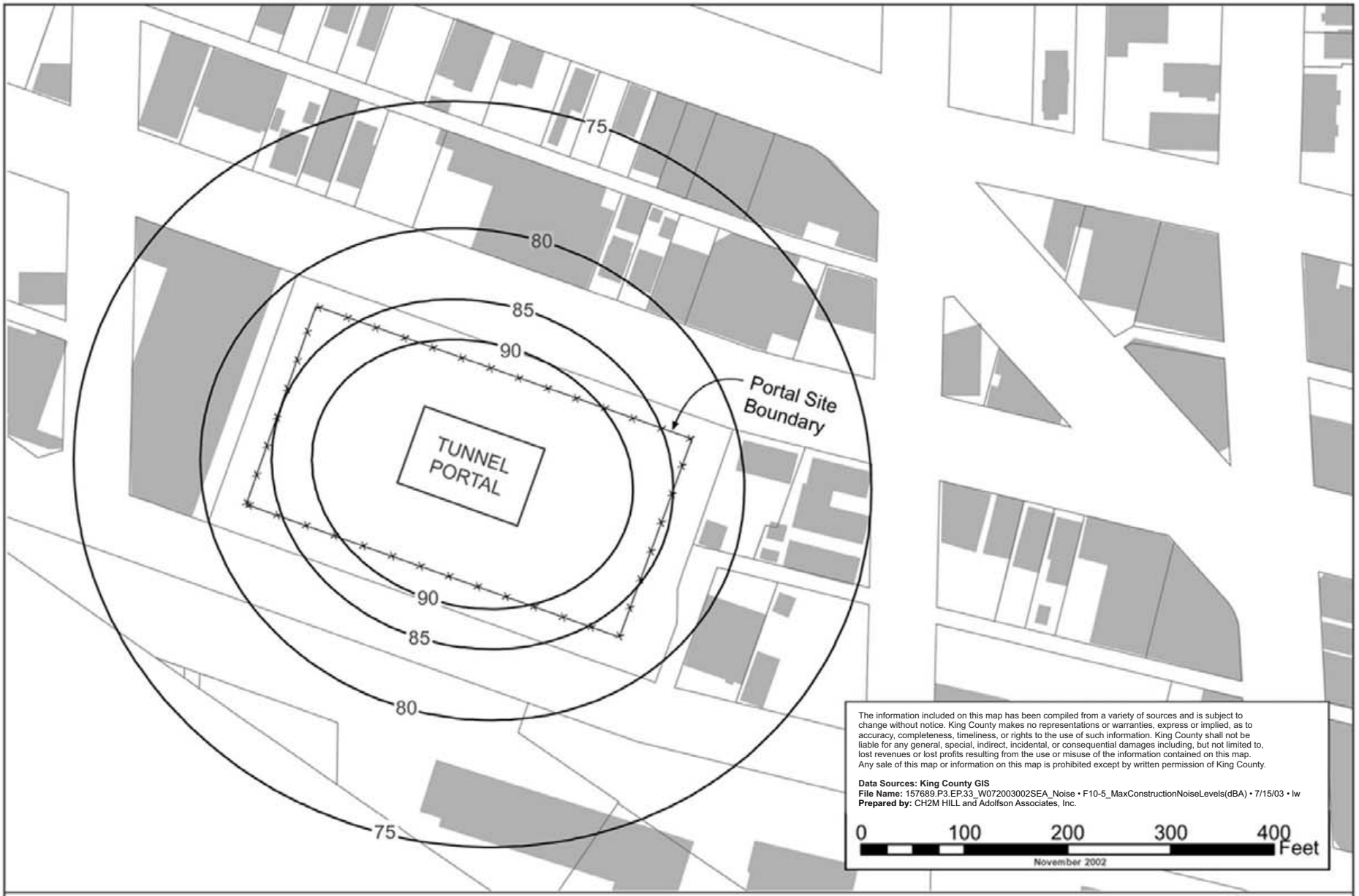

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Figure 10-5

Maximum Construction Noise Levels (dBA) for Approximate Two-Acre Hypothetical Conveyance Tunnel Portal Site

BRIGHTWATER FINAL EIS